REMARKS

Claims 1-3, and 8-11 are rejected under 35 U.S.C. Section 103(a) as being unpatentable over Wood and further in view of JP 3-230,849; claims 4-7 are rejected under 35 U.S.C. Section 103(a) as being unpatentable over Wood in view of JP '849 as applied in claim 1 above and further in view of either Sadamitsu or Itaya et al; and claims 12-19 are rejected under 35 U.S.C. Section 103(a) as being unpatentable over Wood and further in view of either Sadamitsu or Itaya et al. (Office Action, pp. 2-4.) In the Advisory Action dated 02 October 2003, it is asserted that "[a]lthough JP '393 and '394 do not show to move the brushes independently from each other, JP '849 does show that feature to be known."

Attached is a translation of JP No. 3-230849 ("JP '849"). The JP '849 disclosure sets forth problems to be overcome by the invention. The specific problem addressed by JP '849 was that a brush roll extending the full width of a casting roll could not be uniformly compressed against the surface of the casting roll by its spring mounts. This "irregular" contact "formed ridges and valleys on the surfaces of the cooling drums." (JP '849 , p. 3, ll. 14-19.) Therefore, it was "an objective of the present invention to prevent such irregularity in the contact between the brush rolls and the surfaces of the cooling drums." (JP '849, p. 3, ll. 25-26.) To overcome this problem, JP '849 replaced a single brush extending the full width of the casting roll, with a number of smaller brushes (or rolls) 1A and 1B segmented in the direction of the casting roll axis. These segmented brushes generally extend across the width of the casting roll, but with gaps between the brushes. These brush rolls can then be "independently pressed down against the surfaces" of the casting rolls. (JP '849, p. 3, ll. 29-36.) It is clear from the disclosure, however, that "independently" does not mean at different times, in different directions, or for different purposes.

In JP '849, each of the segmented brushes 1A and 1B has an independent spring to apply the pressure to that roll so that the pressure applied to each roll, and thereby the pressure applied to the width of the roll surface, is equal in order to avoid the "irregularities in contact." Implicit is the fact that the brushes are applied to the casting surfaces at the same time, in the same manner, to achieve the same results. Indeed, the "brush rolls are pressed down with a uniform pressure across . . . the surfaces of the cooling drums and polish the surfaces of the cooling drums, such that there are no irregularities of contact, and the cracking of the surface of the cast strip is prevented." (JP '849, p. 4, ll. 32-36.) Thus, although there are separate brush rolls (1A and 1B) they work together, in unison, to achieve the same purpose. This teaches away from the presently claimed invention.

Although the JP '849 seeks to apply its brushes uniformly across the width of its casting rolls, the segmented nature of brush rolls 1A and 1B leaves gaps in the brush coverage. Therefore, another set of similarly segmented brush rolls 10A-10C of "***identical constitution***" must be positioned in the gaps between and at the ends of rolls 1A and 1B, not to perform a different function, nor to move in a different direction, nor to be used at a different time. Rather, brush rolls 10A-10C have "identical constitution" to brush rolls 1A and 1B, and are employed in order to ensure simultaneous and uniform brushing or polishing of the entire surfaces of the casting rolls across their entire width. (JP '849, p. 3, ll. 43-47; p. 4, ll. 19-25.) As expressed in JP '849:

> In the present invention having the constitution described above, the first set of brush rolls 1A and 1B is pressed down onto the cooling drum surface uniformly with a narrow roll width by means of springs 5A and 5B, and the second set of brush rolls 10A, 10B and 10C is similarly positioned to fill in the gaps in the first set of brush rolls and is pressed down onto the cooling drum surfaces uniformly with a narrow rill width by means of springs. Consequently, brush rolls are pressed down with a uniform pressure across virtually all areas of the surfaces of the cooling drums and polish the surfaces of the cooling drums, such that there are no irregularities of contact, and the cracking of the surface of the cast strip is prevented.

(JP '849, p. 4, ll. 27-36.) Therefore, for all practical purposes, brush rolls 1A-1B and 10A-10C expressly and by design operate as a team to form in unison a single brush with identical constitution and purpose in an express teaching away from the present invention. Indeed, if any of the brush rolls were different in construction, or operated independently, in a different manner, or at a different time, the JP '849 goal of uniform brushing and polishing would be frustrated. (JP '849, p. 5, ll. 10-15.) In short, JP '849 in no way discloses or suggests that the brushes be moved or used independently of each other as presently claimed. To the contrary, it teaches that they have the same construction and operate in unison to achieve the same purpose. The '849 reference teaches away from and is remote to the presently claimed subject matter.

Just as JP '849 teaches away from the present invention, so too does Wood, as discussed in the prior submission. As previously discussed, there is no disclosure or suggestion in Wood of providing two brushes of different character to perform different functions in cleaning the casting surfaces of the casting roll at different times during the

casting operation. Therefore, to be sure, Wood is remote prior art from the presently claimed invention which has two brushes of different character: one a main brush and the other a sweeper brush. Moreover, in the claimed subject matter, the sweeper brush is positioned to contact the casting roll surface of the casting roll in advance of the position of the main brush relative to the casting surface of the casting roll. This is not disclosed or suggested by Wood. Further, as previously pointed out, there is no mechanism for the main brush and/or the sweeper brush to move independently into engagement with the casting roll surfaces of the casting roll.

Secondary references Sadamitsu and Itaya et al are even more remote prior art. Sadamitsu discloses a photoreceptor cleaning apparatus for an electrophotographic apparatus having a pair of rotating brushes enclosed within a brush box and engaging the photo sensitive drum. The brushes counter-rotate and the material is sweep from the photo sensitive drum is sweep away from the brushes through a filtering bag within a suction box. Again, in Sadamitsu there are identical brushes that counter-rotate, and no suggestion of brushes of different characteristics to be used during different times in the operation of the apparatus. Itaya et al discloses a large brush cleaning device for an electrophotographic reproduction apparatus wherein a fur brush is contacted as the image receptor for removing electromagnetic toner. In Itaya et al, there is only one brush. None of the features deficient from Wood are disclosed or suggested by these secondary references.

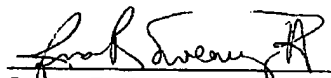
So, too, as previously argued and as acknowledged in the Advisory Action, JP '393 and JP '394 do not disclose or suggest the independently moving brushes of the presently claimed subject matter.

Appl. No. 10/040,092
Amdt. dated 05 Nov 03
Reply to Office action of 05 May 03

Applicants respectfully submit that presented claims 1-19 are in condition for allowance and should be allowed with the application passed to issue. The cited references teach away from and are remote prior art from the presently claimed subject matter. Applicants now petition for a three-month extension of time to effect a timely response, and now authorize the commissioner to charge the $950 extension fee, along with the $770 fee for the contemporaneous filing of an RCE, and any other fees that may be due, and/or to credit any overpayment in fees, to the Account of Barnes & Thornburg, Deposit Account No. 10-0435, with reference to our matter 29385-68773.

Respectfully,

BARNES & THORNBURG.

By: 
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SPECIFICATIONS

1. Title of the Invention

Continuous Casting Apparatus for Cast Strip

2. Claims

A continuous casting apparatus for cast strip in which a reservoir is formed on portion of the circumferential surface of the cooling drums, the molten metal that

is poured into such reservoir is cooled and solidified on the circumferential surface of such cooling drums, forming cast strip, such continuous casting apparatus for cast strip further characterized in that brush rolls that are segmented in the direction of the cooling drum axis and that are in contact with the surfaces of the cooling drums can be independently pressed down against the surfaces of the cooling drums, and in that further brush rolls that are segmented in the direction of the cooling drum axis can be independently pressed down against the surfaces of the cooling rolls adjacent to the former brush rolls in the intervals in the axial direction of such brush rolls

3. Detailed Description of the Invention

Relevant field of industry

This invention relates to a continuous casting apparatus for the manufacture of thin strip in which is reservoir if formed on portion of the circumferential surfaces of twin drum type cooling drums, with molten metal that is poured thereinto being cooled and solidified.

Prior art

In recent years, attention has focused on methods of manufacturing thin cast strip having gauges of from several millimeters to several tens of millimeters in close to final form directly from molten metal such as molten steel and so forth. When these types of continuous casting methods are employed, there is no necessity for the multistage hot rolling process hitherto required, and only light rolling is required to achieve the final shape, and therefore economies are achieved in both labour and equipment.

These types of continuous casting methods consist of the twin drum method in which a reservoir is formed between a pair of cooling drums that revolve in mutually opposed directions, the drum-belt method in which the reservoir is formed between a cooling drum and a belt, and the single drum method in which the reservoir is formed on portion of the circumferential surface of a single cooling drum, and so forth. In all these methods, the cooling and solidification of the molten metal proceeds at that portion that is contact with the surface of the cooling drums and solidified shells are formed. Thus the condition of the surface of the cooling drums has a significant impact on the condition of the solidified shells. For example, if an oxide film forms on he surfaces of the cooling drums and impurities adhere and accumulate from the reservoir part, the surfaces become irregular and local variations in the cooling conditions arise. As a result, the solidified shell is not formed uniformly and cast strip is manufactured with an irregular gauge. Moreover, this irregular state of the surfaces imparts localized accumulations of stress to the solidified shells and is a cause of the development of cracking in the solidified shells.

JP60-184449 and JP62-176650 and so forth reveal the provision of brush rolls which remove the foreign matter adhering to the surfaces of the cooling drums,

in order to produce regularity in the surfaces of the cooling drums. The polishing by these brush rolls maintains the surfaces of the cooling drums in a clean state at all times, and eliminates the adverse effects of the oxide films and foreign matter impurities.

Issues addressed by the present invention

However, it is believed that defects such as vertical cracks and horizontal cracks and so forth are caused when continuous casting is performed while the surfaces of the cooling drums are polished by the brush rolls in this manner. When the inventors of the present invention investigated the mechanism for this development of cracking, it was found that it was greatly affected by the surface state of the cooling drums that had been polished by the brush rolls.

Thus, because the brush rolls were in contact with virtually the full width of the cooling drums along the direction of the axis of the cooling drums, and the brushes were spring-mounted and thus were compressed against the surfaces of the cooling drums, irregularities in contact readily developed because only a single brush was employed, and these irregularities in contact formed ridges and valleys on the surfaces of the cooling drums.

When cast strip was manufactured with this type of cooling drum, cracks developed from the boundary portions of the ridges and valleys that were formed in the surfaces of the cooling drums and appeared in the surface of the cast strip.

It is an objective of the present invention to prevent such irregularity in the contact between the brush rolls and the surfaces of the cooling drums.

Means employed in order to overcome these problems

In order to achieve this objective, the present invention provides a continuous casting apparatus for cast strip characterized in that brush rolls that are segmented in the direction of the cooling drum axis and that are in contact with the surfaces of the cooling drums can be independently pressed down against the surfaces of the cooling drums, and in that further brush rolls that are segmented in the direction of the cooling drum axis can be independently pressed down against the surfaces of the cooling rolls adjacent to the former brush rolls in the intervals in the axial direction of such brush rolls.

Action

In the present invention, the brush rolls are segmented and the brush rolls are formed with springs and the like so that the brush rolls are pressed down against the surfaces of the individual cooling drums, and hence each segment of the brush rolls presses down with uniform pressure and presses against the surface of the cooling drum and eliminates accretions of foreign matter. Moreover, a separate segmented brush roll possessing the same constitution is so disposed as to face the gaps in the axial direction of the former brush roll and performs brush polishing, so that accretions of foreign matter are eliminated from all areas of the surface of the cooling drum without irregularity.

Practical embodiment

The following is a more detailed description of the present invention by reference to a practical embodiment thereof. In Figure 1, first brush rolls **1A** and **1B** are disposed in contact with the surface of the cooling drum **11A** and parallel to the axis **12A** of the cooling drum. The brush roll **1A** is fixed to the shaft **3A**, and the shaft **3A** is supported by the bearing **4A**, with the fulcrum shaft **6** passing through the lower end of the bearing **4A**. The supporting frame **7A** is disposed between the bearings **4A** of the brush roll **1A** side, and the spring **5A** is connected to the supporting frame **7A** by means of the pin **8A**.

The brush roll shaft **3A** is rotated in the reverse direction to that of the cooling drum **11A** through a belt from the motor **9**.

The brush roll **1B** possesses the same constitution as the brush roll **1A**. However, the fulcrum shaft **6** is so constituted as to form the common rotary shaft for the brush rolls **1A** and **1B**, and the brush roll **1B** is mounted together with brush roll **1A** on the stand **2**.

The second set of brush rolls **10A**, **10B** and **10C** is disposed adjacent to the aforementioned brush rolls **1A** and **1B**, and more particularly, the brush roll **10B** is disposed in a position relative to the gap between the brush rolls **1A** and **1B** and the brush rolls **10A** and **10C** are disposed respectively in positions relative to the ends of the brush rolls **1A** and **1B**. The constitutions of the brush rolls **10A**, **10B** and **10C** are identical with those of the brush rolls **1A** and **1B** (details omitted).

In the present invention having the constitution described above, the first set of brush rolls **1A** and **1B** is pressed down onto the cooling drum surfaces uniformly with a narrow roll width by means of springs **5A** and **5B**, and the second set of brush rolls **10A**, **10B** and **10C** is similarly positioned to fill in the gaps in the first set of brush rolls and is pressed down onto the cooling drum surfaces uniformly with a narrow roll width by means of springs. Consequently, brush rolls are pressed down with a uniform pressure across virtually all areas of the surfaces of the cooling drums and polish the surfaces of the cooling drums, such that there are no irregularities of contact, and the cracking of the surface of the cast strip is prevented.

The practical embodiment of the invention shown in Figure 1 is an example of the invention, but any number of segments of the brush roll may be employed axially, and not only two but three or more sets of brush rolls may be employed if necessary.

First, the pressure of each of the brush rolls against the cooling drums was set with the pressure of the first set of brush rolls being between 0.5 kg and 5.0 kg, with the pressure of the second set of brush rolls being set independently of the first set of brush rolls at between 0.5 kg and 5.0 kg, and between 0.5 kg and 5.0 kg as a comparative example. Thin strip of from 1.5 mm to 6 mm in thickness, and

800 mm in width was cast from molten steel at a temperature of 1460° C to 1480° C at a casting velocity of 10 m/min to 200 m/min. The cast slab was examined visually after pickling, and the total length (m) of the cracks that developed within 1 m^2 in the cast strip were measured and compared. As a result, there were no vertical or horizontal cracks in the examples from the present invention, with total cracking being 0 m/m^2, while 0.1 m/m^2 of vertical cracking and 0.2 m/m^2 of horizontal cracking was found in the comparative example.

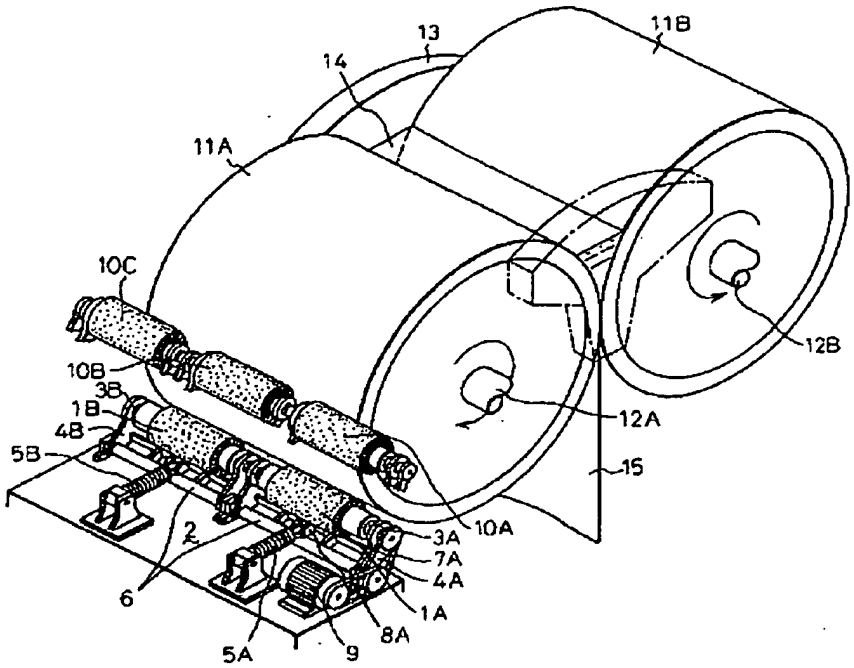
Effects of the present invention

The present invention as described above enables the uniform compression of the rolling brushes across all areas of the cooling drums, and hence no irregularities in the polishing of the surfaces of the cooling drums occur, and hence it is possible to manufacture thin cast strip with excellent surface finish free of such defects as vertical cracking and horizontal cracking, conferring great commercial advantage.

4. Simplified description of the drawing

Figure 1 is an oblique schematic drawing of a practical embodiment of the present invention.

1A, 1B ... Brush rolls, **2** ... Stand, **3A, 3B** ... Shafts, **4A, 4B** ... Bearings, **5A, 5B** ... Springs, **6** ... Fulcrum shaft, **7A, 7B** ... Supporting frames, **8A, 8B** ... Pins, **9** ... Motor, **10A, 10B, 10C** ... Brush rolls, **11A, 11B** ... Cooling drums, **12A, 12B** ... Cooling drum shafts, **13** ... Side weir, **14** ... Reservoir, **15** ... Cast strip



1A, **1B** ... Brush rolls, **2** ... Stand, **3A**, **3B** ... Shafts, **4A**, **4B** ... Bearings, **5A**, **5B** ... Springs, **6** ... Fulcrum shaft, **7A**, **7B** ... Supporting frames, **8A**, **8B** ... Pins, **9** ... Motor, **10A**, **10B**, **10C** ... Brush rolls, **11A**, **11B** ... Cooling drums, **12A**, **12B** ... Cooling drum shafts, **13** ... Side weir, **14** ... Reservoir, **15** ... Cast strip

Figure 1